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ABSTRACT

An observational study was conducted to investigate the computer activity of children in a preschool classroom. Thirty-nine 3- to 5-year-old children were observed using a computer over nine weeks during a daily one-hour free play period. Different types of computer programs were available. During one half of the sessions, an adult knowledgeable about computers was available to the children for aid and support; during the remaining sessions, the teacher was not available. The children's physical and verbal behavior while using the computer was observed and recorded. Overall, the children enjoyed using the computer and preferred to use it with the teacher or a peer rather than alone. Additionally, children's activity at the computer was not significantly altered by the presence of the teacher. The observations indicated that preschool children can work effectively and cooperatively at a computer with minimal teacher supervision and that the computer does not appear to attract children to the detriment of other areas of social and cognitive development. Relatively few age or sex differences were reported. In terms of ability, more expert children were found to work at the computer more often than less expert children and also to work more efficiently. The less expert children tended to work for longer periods of time than the experts. The more expert children also used a greater variety of programs. (Author/BB) (Author/BB)

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An Observational Study of Preschool Children's Computing Activity

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ABSTRACT

An observational study was conducted to investigate the computer activity of children in a preschool classroom. Thirty-nine 3- to 5-year old children were observed using a computer over nine weeks during a daily one hour free play period. During one half of the sessions an adult knowledgeable about computers was available to the children for aid and support, during the remaining sessions the teacher was not available. The childrens' physical and verbal behavior while using the computer was observed and recorded. Overall the children enjoyed using the computer and preferred to use it with the teacher or a peer rather than alone. The pattern of results support previous studies that reported that the computer environment may encourage rather than inhibit social interaction. Additionally, children's activity at the computer was not significantly altered by the presence of the teacher. These results support the idea that preschool children can work effectively and cooperatively at a computer with minimal teacher supervision and that the computer does not appear to attract children to the detriment of other areas of social and cognitive development.

An Observational Study of Preschool Children's Computing Activity

The use of computers in classrooms has been increasing rapidly in the last few years. This trend has even extended to preschools where children are being introduced to computers at younger and younger ages. Unfortunately, our knowledge of the educational and social benefits or problems of computer use, especially at these early ages, has not kept pace with the rapid introduction of computers. Indeed, many parents and educators have voiced concerns regarding computer use in the early childhood education. Questions regarding whether computer use will detract from other areas of social and cognitive development, and what types of controls or limitations on computer use should be established in the classroom, remain for the most part unanswered. The purpose of this investigation was to explore computer use by preschool children when they were free to choose between a computer and other classroom activities.

A primary concern of both parents and educators regarding the use of computers by young children is related to the overall attractiveness of the computer. Stated simply, the argument is that the inherent attractiveness of computers and their immediate reinforcement schedules will cause children to gravitiate towards computers to the detriment of other areas of social and cognitive development (Barnes & Hill, 1983). Similar concerns have been addressed regarding young childrens exposure to video games (Loftus & Loftus, 1983) and television. Studies examining young childrens' computer use have found the computer to be a popular activity (Muller & Perlmutter, in press; Lipinski, Nade, Shade, & Watson, 1984). Muller & Perlmutter (in press), for example, found that the computer was occupied by one or more children 100% of the time it was available. In light of this concern, Lipinski et al (1984), examined computer use in relation to other classroom activities. These researchers found a slight decrease in time spent on other classroom activities upon introduction of a computer into a preschool classroom, but after eight weeks of exposure to the computer, all but one of the other classroom activities had regained their former levels of activity. It appears in this instance that the computer served to replace one of the less interesting classroom activities and

did not differentially attract children to the detriment of all other classroom activities. Although this research addresses the concern of computer attractiveness, the question of its prolonged attractiveness over long periods of time remains to be addressed. If we study computer attractiveness when the computer is a new addition to the classroom, the question of the computer's effect upon the classroom is hopelessly confounded with the its novelty.

A related issue is that computers and the software associated with them are designed primarily for individual use, rather than group cooperation. Fears have been raised that computer use in the formative years will detrimentally affect the social experiences of young children. Reports in the popular press of early computer proteges spending countless hours on their home computers tend to lend credence to this concern.

Research examining computer use in the elementary schools, however, appears to show that this concern may be unfounded. A number of studies in recent years have shown that the computer may actually stimulate interaction and collaboration in classrooms and that the computer often becomes the focal point for much social activity (Hawkins,Sheingold, Gearhart, & Berger,1982; Hawkins, 1983; Levin & Kareev, 1980; Ziajka, 1983). Although most of these reports are concerned with computer use in elementary schools, use of the computer by preschool children appears to mirror that found with older children (Muller & Perlmutter, in press; Piestrup, 1982). Muller and Perlmutter (in press), for example, found that preschool children collaborated more with their peers more while working on a computer than while working on puzzles in the classroom.

Again, in order to truly understand the role of the computer in stimulating social interaction in the classroom, we must address the question of whether the social activity at the computer is due to the computer itself or to the novelty of the computer in the classroom. Further difficulties with intrepreting studies examining social interaction during computer use in the classroom are caused by the fact that most of the studies that have examined computer use and its influence on social activity have been conducted in rather formal instructional settings. This environment, which involves close teacher supervision, most probably does not encourage a great deal of social interaction in general. Teachers, however, fearing the development of

socially isolated computer users, may actually encourage and support more social interaction and cooperation during computer activities than they would during other classroom activities. Therefore, the more unstructured environment of some preschools may actually be a better environment in which to study the natural development of patterns of computer use.

Another concern that has been voiced primarily by classroom teachers is that integrating computers into the classroom environment requires close teacher supervision, creates scheduling problems, and requires different classroom management techniques (Lantz & Edyburn, 1985). Indeed, many teachers have reported being frustrated and disappointed by the difficulties caused by the addition of a computer to their classroom (Dickson, 1985). Although a number of researchers have discussed the importance of adequate computer training for educators (Clements, 1983; Sheingold,1983; Oliver, 1983), few studies have examined the actual role of teachers in classroom computer activities. Muller and Perlmutter (in press) have found that with some introductory training children need relatively little teacher involvement to use computers in an effective manner. Others have argued that at least for preschool children, the presence of an adult or more competent peer is necessary for effective computer use (Brady & Hill, 1984). It is obvious that young children will need a certain amount of instruction and supervision in their early encounters with computers; it is less clear, however, how much supervision and assistance these children will need after gaining some experience with computer use.

There are a number of questions regarding the development and behavior of children who acquire expertise with computers which relate to the issues discussed earlier. For example, it is commonly believed that such children are the ones most likely to suffer socially. Related to this issue is a concern about the equity of computer use in the classroom. Many teachers and parents feel that boys will dominate use of the computer in the classroom, and therefore be more prone to become socially isolated, as well as being more likely to develop computer expertise (Barnes & Hill, 1983).

A number of studies examining computer use in elementary schools have reported the emergence of children who were perceived as computer experts (Sheingold, 1983; Hawkins,

Sheingold, Gearheart, & Berger, 1982). In an investigation of 8- to 11- year-old's computer use, Hawkins et al (1982), found that computer expertise was perceived similarly by both teachers and students. However, it should be noted that in this study, though teachers identified a number of girls who were knowledgeable in computer use, both teachers and children selected only boys as the classroom "experts". Although the relationship between classroom competence and computer use has been examined in the preschool(Lipinski et al, 1984), little is known about the emergence of computer expertise in preschool children.

The aim of the present study was to examine preschool children's use of the computer in a free access situation where the computer was no longer a novel object. It was hoped that by examining preschool children's use of computers in this environment we might be able to address more adequately the concerns of parents and educators regarding children's use of computers. Differences in children's behavior and verbalizations were compared when a computer instructor was available to the children for support and guidance, and when the children worked alone or with peers. In addition to an exploration of the overall pattern of computer use, this study attempted to examine whether differences in childrens' ability to use a computer could be detected at such a young age, and whether differences in computer ability resulted in differences in behavior or social interaction.

METHOD

Subjects

The subjects were 39 children (24 females and 15 males) in a younger and older classroom at the University of Minnesota Child Care Center. The mean age of the 19 children in the younger classroom was 3 years, 11 months (3 years, 5 months to 4 years, 7 months) and the mean age of the 20 children in the older classroom was 5 years, 1 month (4 years,8 months to 5 years, 7 months).

Apparatus

An Apple II computer with 48k memory, a color monitor, two disk drives, a standard keyboard, and a drawing pad was available in a location accessible to children in both

classrooms. There were 17 software programs on five diskettes which the children could choose to work with. These included an alphabet game, five letter and word recognition games, four arithmetic and number games, two concentration-type memory games, four games which attempted to get children to focus on general concepts (left, right, above and below), and a menu driven drawing game. All of these software programs were commercially available.

Procedure

The subjects' behavior at the computer was observed for nine weeks during daily one hour freeplay sessions. The children all had approximately six months of exposure to the computer with varying levels of instruction prior to this investigation. During freeplay sessions in which computing behavior was observed the children had free access to the computer and could choose to use the computer or a number of other classroom activities. When a child came to the computer he or she could choose to use the program which was currently in use or could request that a teacher switch programs. For half of the freeplay sessions an adult knowledgeable in the use of computers was available for support and assistance (teacher present condition). No restrictions were made on the children's use of the computer except that classroom teachers monitored the children's performance to ensure that no one abused the equipment and to ensure that no child disrupted another child's activities. The teachers were asked to interact with the children who were using the computer in the same manner as they would interact with children performing other activities in the classroom. Children could choose to come and go as they pleased, either working alone or in small groups. During thirty minutes of each session the children's and teacher's verbalizations were audiotaped.

Performance Measures

Behavioral Data: In both the teacher present and teacher absent conditions an observer seated a few feet from the the computer area coded the behavior of the children as they worked at the computer or watched another child at the computer. For each child, the time of arrival and departure from the computer area was recorded, as well as the occurrence of any of three types

of behavior. These behavioral categories related to the type of activity the child was performing at the computer, whether it was directed towards others, and whether the child appeared to be enjoying himself or herself. Frequency counts for each session were obtained for computer commands, pointing, and affective displays. Table 1 lists the behavioral categories as well as all other dependent measures.

Insert Table 1 About Here

Three observers, working in pairs, practiced together until a criterion of 80% agreement was obtained on all categories. Percent agreement was calculated by dividing the number of agreements by the total number of behaviors recorded. The final inter-observer agreement on 10% of the sessions averaged 86% for all categories with a range of 81% to 93%.

VerbalData: The children's and teacher's verbalizations while at the computer were transcribed from the audiotapes and each statement was coded along three dimensions. These dimensions included: who initiated the interaction (self, peer, or teacher), the content of the statement (computer related, program related, actor related, or off-task), and the form of the statement (question, bid for attention, instruction, or evaluation). Approximately 50% of the children's utterances fell into these categories. The remainder of the children's speech was comprised of elaborative statements, bids for attention, and uncodeable utterances. A statement was considered to be a separate utterance if it was separated from other speech by a pause or if a shift in content occurred. Due to the large variation in the number of utterances between children a proportional measure of the number of utterances in a category divided by the overall number of codeable statements was used in the analysis of the verbal data. Table 1 lists the verbal dimensions that were coded and defines the subcategories.

After practicing on a number of preliminary transcripts, inter-coder reliability was calculated on 10% of the actual transcripts. The average inter-coder agreement was 85% on all categories, with a range of 82% to 93%. Percent agreement was calculated using the same

method as utilized in determining percent reliability in the coding of the behavioral data.

Post-test Measures:

Following the the final week of observation, subjects were individually administered a number of post-measures. These measures were designed by the experimenters to assess how much the children enjoyed working with the computer, their perceived ability level, and who the subject thought was the best in the class at using the computer.

Childrens' Enjoyment Ratings: To determine how much the children enjoyed using the computer, the children were shown a series of simple faces (from a big frown to a big smile) and asked which face was most like theirs when they played at the computer. This question was repeated to assess how much the children enjoyed using the computer alone, with a peer, and with the teacher. In order to determine if the children preferred to use the computer with a friend the children were asked to name the person they would most like to use the computer with. If a child mentioned the teacher they were asked to name the child they would most prefer to work with. Children were also asked which programs they preferred to use.

Childrens' Ability Ratings: As part of the of the child questionnaire each subject was asked to assess their own ability to use the computer. The children were shown a series of stars which corresponded to different ability levels (one star= novice, five stars=expert). The rating scale was explained to them and they were asked to pick the group of stars that described their own ability to use the computer. In addition, the children were asked to list the three children who they thought were the best at using the computer. In order to develop a rank ordering of children by ability, children were ranked by the number of first, second, and third place listings they received.

Teacher's Ability Ratings: At the end of the observation period, the computer instructor was asked to rate each of the children on their overall ability to use the computer. The teacher was instructed to use a five point rating scale similar to the one given to the children. After assigning an ability rating to each child the teacher was instructed to rank order the children within each of the rating levels, so that the teacher's rank ordering could be compared to the rank ordering based on the childrens' responses. For analysis of ability effects the upper and

lower third of the children according to the teacher's ratings were compared.

Parental Questionnaire:

A questionnaire was designed for this study in order to determine the kind of exposure children had with computers outside of the classroom, parental attitudes towards computers, and parental experience with computers. This questionnaire was distributed to the parents of all 39 children who participated in this study. Twenty-six of the questionnaires were returned, resulting in a return rate of 67%.

Results

Due to the observational nature of this study, the results in each of the following sections will be introduced first in a descriptive manner. After general descriptions of what went on at the computer have been presented, any significant results that were found beween groups will be discussed. Unless otherwise noted, all significant results were determined on the basis of planned comparisons between groups.

Questionnaire

Thirty percent of the 26 parents who completed the questionnaire reported owning a personal computer for one month or longer. The ages cited for a child's first experience with a computer ranged from under two years to four years (mode = 3 years). Fifty percent of the respondents mentioned that their children used a personal computer in a place other than the child care center. The most frequently cited location was the home, followed by a friend's home and the parent's work place. Thirty-five percent of the families replied that their child used a computer outside of school at least once or twice a month. The highest child usage outside of school was five or more times a month and this occurred in families that owned a personal computer. Of those who reported that their child used a computer outside of school, 15% reported that their child uses the computer alone, while the majority indicated that a parent, sibling, or unrelated adult or child is usually present when the child uses the computer. The computer activities reported to be used most frequently were games and educational games, followed by "playing around with the word processor".

Overall Computing Behavior

A listing of the mean scores for all the dependent meesures may be seen in Table 2. During freeplay periods the computer was occupied by one or more children 78% of the time. The average length of computer use was eight minutes and ranged from less than one minute to 32 minutes. In general, the computer was used fairly regularly by a number of different children, but three children did not use it at all during the nine week period. Though the number of times a child used the computer varied quite widely (from 0 to 27 times), the mean number of times the computer was used by children was 8.2 times during the observation period or roughly once a week. While at the computer, the children executed an average of 3.2 computer commands per minute, pointed as a self-directed aid .36 times per minute, pointed to gain anothers attention .37 times per minute, and exhibited some form of positive affect .23 times per minute. Displays of negative affect were quite rare, occurring only a few times throughout the entire time of the study.

Insert Table 2 About Here

Overall Verbal Behavior

While at the computer children made an average of 28 statements per episode. These were predominantly self-initiated (69%) rather than teacher initiated (13%) or peer initiated (2.4%). Off-task utterances comprised 15 % of the children's utterances. Children also talked more about program related issues (54%), than about the overall workings of the computer (13%) or turn-taking issues (18%). Additionally, a large proportion of the statements were made up of instructions (59%) and questions (21%). Evaluative statements about others' performance or about the programs themselves made up less than 6% of the utterances.

Program Preference

Koala, a rather sophisticated drawing game was the most popular program reported by children. This program was mentioned by 35% of the children as their first choice of games to use on the computer. The next two most popular reported programs were an alphabet game (10%) that allowed children to sing along with the computer and a concentration type memory game (10%) which allowed more than one child to use the computer at a time. A counting game,

which followed correct responses with a video display similar to many video games, was listed by 7% of the children as their first choice.

This pattern of results was similar to the pattern of actual program use. The drawing game was the program most often used by children working at the computer (30%), followed by the concentration type memory game (15%), and the alphabet game (13%). The next two most frequently used programs were number games. One of these programs, which was used 10% of the time, involved guessing the number that the computer was "thinking of". Following a guess the computer responded that the number was higher or lower than the child's guess. The other number game, which was used 8% of the time, involved reversing a sequence of numbers so that they were in the correct order.

Enjoyment Ratings

Children reported that they enjoyed working with the computer. The mean rating of enjoyment was 4.6 out of a possible 5. In addition, they preferred using the computer with a teacher present significantly more than by themselves (teacher present = 3.6, alone = 2.8, $t(31) = 1.92$, $p < .05$). Children reported that they preferred working with a peer rather than alone but this difference was not significant (with peer = 3.4). These results may be seen in Figure 1. This finding was supported by actual observation. Children were observed working alone only 30% of the time in the teacher absent condition and without any peers only 35% of the time in the teacher present condition.

Insert Figure 1 About Here

In order to examine if children used the computer with friends, the names given by the children to the question "who would you most prefer to use the computer with?", were compared with the children that were actually working at the computer with them. Four of the children mentioned the teacher as a preferred companion. In general, there was little agreement between who a child said they would most prefer to use the computer with and who they actually played with. Only one child mentioned the child they were most frequently at the computer with as the prefered companion. Three other children's preferred companion was among the second or third

most frequent actual companions.

Teacher Effects

Children used the computer significantly more often over the course of this study when the teacher was present (m=5.9 times) than absent (m=4.2 times), $t(31) = 3.13$, $p < .05$. Additionally the computer was occupied a larger proportion of the time when the teacher was present (86% of the available time) than absent (68% of the time). A number of children, however, only used the computer in the teacher's absence (4) or only in her presence (2). Rather surprisingly, teacher presence had little effect on the length of time children spent at the computer or the number of computer commands executed. The children did, however, exhibit more other directed pointing in the presence of the teacher than in her absence (.54 per minute versus .23 per minute, $t(31) = 3.24$, $p < .05$). The teacher's presence did not significantly affect the mean number of children's utterances while working at the computer, nor did it appear to alter significantly the overall form or content of those utterances.

While present at the computer, the teacher performed an average of 11 computer commands per hour, pointed towards the screen to direct a child's attention 10.5 times per hour, and made an average of 41 statements per child. Eleven percent of these statements were initiated by the children through questions. In general, the teachers comments were comprised mainly of instructions (39%) and questions (30%) which were predominantly instructional in nature (e.g. "what do we do next?"). Positive evaluations of the childrens' performance comprised 10% of the teacher's statements. A large proportion of the teacher's speech related to aspects of the program in use (39%) and to actor related issues such as turn-taking and sharing (19%). In contrast with the childrens' speech, the teacher produced a larger proportion of statements relating to the overall functioning of the computer (21%). Figure 2 shows the proportion of teacher's and children's speech in each category.

Insert Figure 2 About Here

Age Effects

There were relatively few age or sex differences. However, younger children had a

greater propensity for other directed pointing than older children (m=.51 instances of pointing to gain another's attention per minute for the older children versus .28 for the younger children, $t(31) = 7.19$, $p < .05$). Younger children also rated playing with a peer at the computer as less enjoyable than older children (2.9 versus 4.3 out of a possible rating of 5 for greatest enjoyment, $t(31) = 1.92$, $p < .05$). Furthermore, older children were perceived by the teacher to be slightly more competent at the computer than younger children (mean rank for older children=7.7, mean rank for younger children=16.8, $t(31) = 2.91$, $p < .05$).

Though no significant differences emerged, a number of interesting patterns were found in the teacher's speech with regards to the age of the children using the computer. The teacher gave a larger proportion of actor related statements to younger children than older (30% versus 18%), as well as larger proportions of instructions (39% versus 30%), and computer related statements (19% versus15%). On the other hand, the teacher made a larger proportion of program related statements to the older children (36% versus 28%).

Sex Effects

Though no sex differences emerged in the teacher's ranking of children by ability, boys were ranked more highly than girls by the children themselves (mean rank for boys=6.9, mean rank for girls=15.9, $t(31) = 3.3$, $p < .05$). No other significant sex differences were obtained.

Some interesting trends were found in the teacher's speech to boys and girls. First, the teacher gave the same proportion of instructions to both boys and girls (39%), yet directed more questions towards boys than girls (x=32% for boys, x=24% for girls), and made a larger percentage of actor related statements to boys (x=23% for boys, x=17% for girls).

Ability Effects

A number of significant differences were found between children rated high versus low in computer expertise. Not surprisingly, more expert children were found to work at the computer more often than less expert children (m=19 episodes for the expert, m=5 times for the less expert $t(18) = 3.85$, $p < .05$) and also to work more efficiently (m=4.3 commands per minute versus m=1.9 commands per minute, $t(18) = 3.29$, $p < .05$). In addition, the less expert children tended to work for longer periods of time than the experts (m=9 minutes per

stay for the less expert, m=7 minutes for the expert). The more expert children also used a greater variety of programs over the nine week period than the less expert children (m for experts=16 programs, m for less expert=5 programs, $t(18) = 2.98$, $p < .05$).

Different patterns of verbal utterances were also observed for the different groups, however, these groups did not differ in the percentages of speech belonging to any of the categories. The more expert children produced more overall utterances than the less expert children $t(18) = 2.32$, $p < .05$, gave more instructions to others, $t(18) = 2.76$, $p < .05$, and asked more overall questions, $t(18) = 2.41$, $p < .05$. In addition, the more expert children produced more positive evaluations of their peers than less expert children , $t(18) = 2.55$, $p < .05$, and made more positive comments about the program they were using, $t(18) = 2.16$, $p < .05$.

No significant differences were found in the overall speech of the teacher to children of different abilities, but a number of trends were observed. The teacher made a larger proportion of actor related statements to less expert children (m=27% versus m=20%)and gave a larger proportion of instructions to the less expert children (36% versus 29%). In contrast to this the teacher made a larger proportion of program related comments when working with a more expert child than with a less expert child (38% versus 25%) and asked a larger percentage of questions to the more expert children (30% versus 23%).

Children's ratings of their own computer abilities were found to be significantly different from the teacher's rating of their own ability (self-rating =4.5, teacher rating = 3.6, $t(25) = 3.43$, $p < .05$). Children of all ages and of both sexes rated themselves higher in computer ability than the teacher did (See Figure 3.). In addition, the teacher's rank ordering of children by ability was not significantly related to the rank order derived from the children's reports (Kendall Tau = .28, n.s). Of interest is the fact that only one child mentioned her own name as one of the three best at using the computer in the class.

Discussion

Rather surprisingly, the computer instructor in this study had little overall effect on the children's computer activity. The presence of the teacher did serve to attract the children to the

computer more often and increase their efficiency slightly, but did not alter the pattern of their overall computer or verbal behavior. The opportunity to work on a one to one basis with a teacher may have been the cause of the children's greater computer use when the teacher was present. There was little opportunity for such interaction in the other classroom activities, perhaps other activities that allowed similar teacher-child interaction would prove to be as popular as the computer activity.

One could imagine that the teacher would be required to play a greater role in a situation where the computer was a novel addition to the classroom. In this instance, where the computer had been in the classroom for over a year, the children were able use it with relatively little teacher support and guidance. In support of this idea is the observation that the teacher often ended up playing some of the games with the children rather than actually teaching them. At times her role appeared to be more of a trouble shooter than an instructor. It should be stressed, however, that all of the children received some instruction in the working of the computer prior to the start of this study and that their behavior at the computer was monitored from a distance by the classroom teachers. Therefore, with adequate early instruction and guidance preschool children appear to be able to use a computer in an effective manner without close supervision.

In general, this study supports the findings of previous reports that the computer environment is a socially active one. Most children preferred to work at the computer with another individual, either another child or a teacher. It would appear that the fear of the development of socially isolated computer users, at least when computers are introduced at the preschool level, seems to be unfounded. Indeed, many children in this study often attempted to direct another child's, a teacher's, or even an observer's attention to the work that they were doing at the computer. It should be stressed that many of the games currently available for young children to use at the computer are not designed to be used by more than one individual at a time (the concentration type memory games are an exception, but they also contain an option to be played alone). In this situation, many children were content to watch and support another's computer use, but as children get older and more familiar with the computer it may be

necessary to develop more cooperative computer programs to ensure that the computer does not develop into a solitary activity.

The computer remained a popular activity in the classroom even though children had over six months prior exposure to the computer before this study was conducted. Unlike previous studies that reported that the computer was always occupied whenever it was available (Muller & Perlmutter, in press), there were times during the present study when the computer was unoccupied. Furthermore, since children used the computer only an average of once a week and then only for relatively short sessions (average lenght of use was 8 minutes per child), it appears that concerns about the computer attracting children to the detriment of other areas of social and cognitive development have little foundation.

Definite preferences did emerge with regard to the type of programs which were used by children. Children preferred a rather sophisticated menu driven drawing game that required relatively good eye-hand coordination and the ability to go back and forth between a menu and picture screen. This program allowed children to design and create their own pictures or to alter existing pictures found in the memory. The other popular games were ones that enabled more than one child to interact with the computer, either through structured turn-taking as in the concentration type game, or through singing along with the program as in the alphabet game. The remainder of the other programs, many of which involved drill and practice or were largely repetitive in nature, were not as popular as these three programs. It appeared that children often became bored with games in which they quickly mastered all the simple processes required of them. These results suggest that programs which allow children a relatively large degree of creativity or control, or allow children to interact with others, may be preferred by preschool children over more structured programs or programs designed to be used individually. Programs which grow more complex with a child's growing competencies might ensure continued interest and continued educational benefits from computer use.

The emergence of recognizable classroom computer experts was rather surprising at this young age. Of interest was the finding that, though the teacher rated a number of girls as experts, the children rated the abilities of boys in general to be higher than those of girls. This

finding is similar to that found by Hawkins, Sheingold, Gearheart, and Berger (1982), yet those researchers found that both the teacher and the students named only boys as "experts". It would be interesting to see if the classroom teachers, who had less contact with the children using the computer than the computer instructor, would rate children on ability measures in a manner similar to the children or the instructor. Informal discussions with one of the classroom teachers lend support to the notion that boys may be perceived as more expert by the classroom teacher when in fact there are girls of equal or greater ability.

Another interesting finding relating to the issue of expertise, is that children of high and low ability levels did not differ in their overall content or form of speech, but did differ markedly in the amount of overall speech produced while at the computer. That is, the more expert children were exceedingly verbal, producing more statements of all types of speech analyzed in this study than the less expert children. Although the current data do not allow for such an analysis, it would be interesting to determine whether the the more expert children "fill in" for the teacher in her absence by providing more guidance and support to their peers. Anecdotal evidence from observations conducted over the course of this study lend at least tentative support to this notion. Indeed one of the computer experts observed in this study (a girl) went on to instruct first graders in computer use while she was still in kindergarten.

In summary, it appears that many of the concerns regarding young childrens' computer use voiced by parents and educators are not supported by the results of this study. Preschool children were found to be quite capable of using a computer effectively even with minimal teacher supervision. Fears of the development of socially isolated computer users seem to be unfounded, since children prefer to use the computer with peers or a teacher. Additionally, even at this young age computer experts emerge. These children differ from their classmates not only in their actual computer abilities, but also in their greater verbal production while at the computer.

Table 1. Dependent Measures

Behavior Categories	Definition	Example
Frequency of use	How often a child was at the computer over the coding period	
Mean Length of use	Average time spent at the computer in minutes for any one episode	
Program	Which program and function the child used while at the computer	
Commands	Any behavior resulting in a change in video display.	usually a single keypress
Pointing		
Self-directed	pointing to the screen or keyboard which appears to aid the child in producing a correct response or maintaining attention	often accompanied by counting or saying the alphabet
Other-directed	Pointing to the screen or keyboard that appears to an attempt to direct another's attention	often accompanied by exclamations such as "look" or "see what I did"
Affect		
Positive	Any behavior that shows that the child appears to be enjoying themselves.	laughter / applause
Negative	Any behavior that shows that the child is not enjoying themselves	crying / pouting
Verbal Categories		
Initiation		
Self	Any statement that is not preceded by a question or is not a direct response to a statement from another	
Teacher	A statement that is a direct response to a teachers question or comment	
Peer	A statement that is a direct response to a question or comment from a peer	

Content		
Computer	Statements dealing with the operation of or relating to the computer in general	"How do I get another program?"
Program	Statements concerning the workings of or relating to the program currently in use	" How do I make it do that?"
Actor	Statements pertaining to turn-taking or sharing	"it's my turn now"
Off-task	Any statements that have nothing to do with the computer, program, or turn-taking	"I'm going to go to Jim's house after school"
Form		
Question	Any task relevant request for information	"What do I do now?"
Instruction	Any statement or response to a question that provides information useful to running a program, the computer, or aiding turn-taking	" You need to press that one"
Evaluation	Any statement that provides feedback about the program, the computer, or an actors performance	"That looks nice"

Table 2. Dependent Measures and Mean Scores

Dependent Measure	Overall Mean	Condition		Age		Sex		Ability	
		Teacher Absent	Teacher Present	Young	Old	Male	Female	High	Low
Behavioral Measures									
Percent of use (time used/time available)	78	68 *	86	15	29	28	72	55	5
Number of Programs (out of 17)	8.5	3.6	3.3	6.3	8.7	7.9	8.9	5.2 *	16.7
Frequency of Use (number of times)	8.2	4.2 *	5.9	7.2	11.0	7.5	11.7	5.1 *	19.1
Length of Use (minutes per use)	8.1	8.1	8.2	8.0	7.6	8.2	7.8	8.7	7.3
Commands (per minute)	3.2	3.1	3.3	2.6	3.0	3.4	3.1	1.9 *	4.3
Self-directed Pointing (per minute)	.4	.3	.3	.3	.3	.4	.3	.5	.3
Other-directed Pointing (per minute)	.4	.2 *	.5	.5 *	.3	.4	.4	.4	.4
Positive Affect (per minute)	.2	.2	.3	.3	.2	.2	.3	.2	.4
Number of Peers Present (per program used)	1.1	1.3	1.0	1.3	1.3	1.2	1.1	1.3	.9
Verbal Measures (in percent of utterances fitting each category)									
Initiation									
Self	69.0	80.3	69.0	70.0	66.5	74.9	64.2	64.6	67.4
Teacher	13.0	-	-	13.7	12.4	11.7	13.9	15.6	12.0
Peer	2.4	4.2	2.5	2.0	2.2	2.5	2.2	1.2	2.2
Content									
Computer-related	13.0	16.3	11.9	12.4	11.9	10.8	13.8	15.2	11.3
Program-related	54.0	51.8	63.9	55.2	52.3	56.6	51.3	53.6	53.4
Actor-related	17.8	23.0	15.1	18.3	16.9	21.1	15.2	12.6	16.9
Off-task	16.1	8.8	9.1	14.1	18.9	10.6	19.6	18.6	18.3
Form									
Question	21.2	22.0	22.0	16.8	21.5	21.7	19.5	23.3	19.6
Evaluative	5.9	5.7	5.9	3.3	7.3	7.9	3.8	2.7	6.6
Instruction	58.8	63.0	63.0	65.8	52.4	59.0	57.1	55.2	55.4
Total Utterances	27.3	36.4	39.3	34.1	29.3	25.7	28.9	14.3 *	50.9

Enjoyment Ratings (1=not at all, 5=very much)									
Overall	4.6	-	-	4.8	4.0	4.7	4.6	4.3	4.8
With the Teacher	3.7*	-	-	3.5	3.7	3.8	3.4	2.9	4.1
Alone	2.8*	-	-	2.8	3.7	2.9	2.7	3.3	2.5
With a Peer	3.4	-	-	2.9	4.3	3.0	3.6	3.0	4.1
Ability Ratings (1=novice, 5=expert)									
Self-rating	4.5*	-	-	4.0	4.6	4.5	4.4	4.1	4.5
Teacher-rating	3.6*	-	-	2.6	3.9	2.6	3.3	-	-
Rank-ordering by Ability (1=best in class, 25=worst in class)									
Derived From Children's reports				14.8	13.4	6.9 *	15.9	17.1	12.1
Derived From Teacher's ratings				16.8 *	7.7	11.4	12.7	-	-

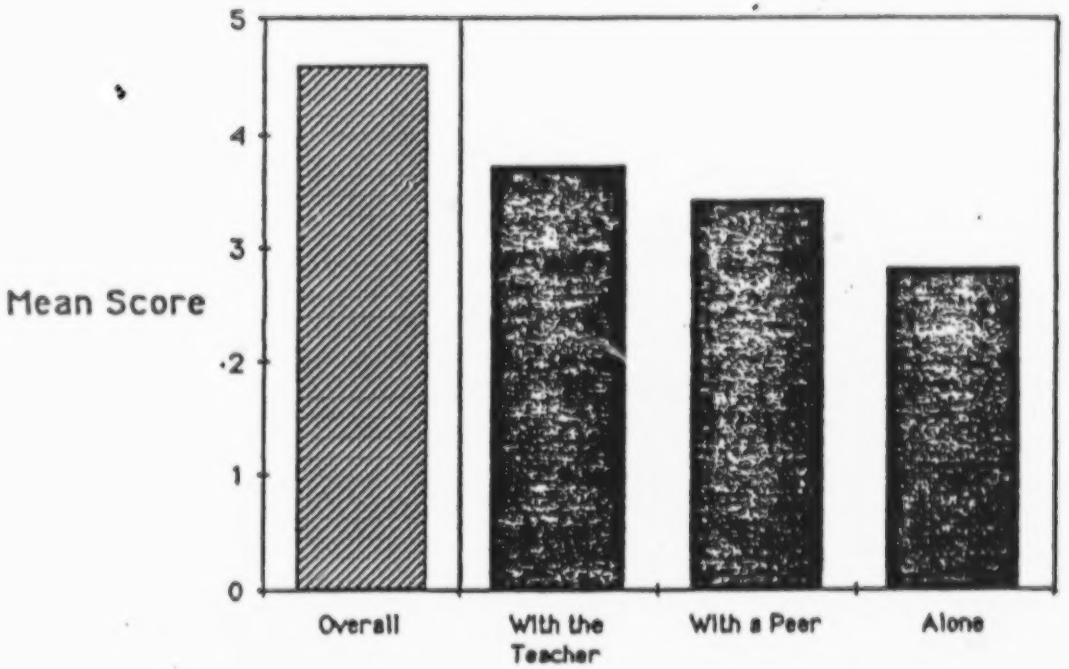
* $p<.05$

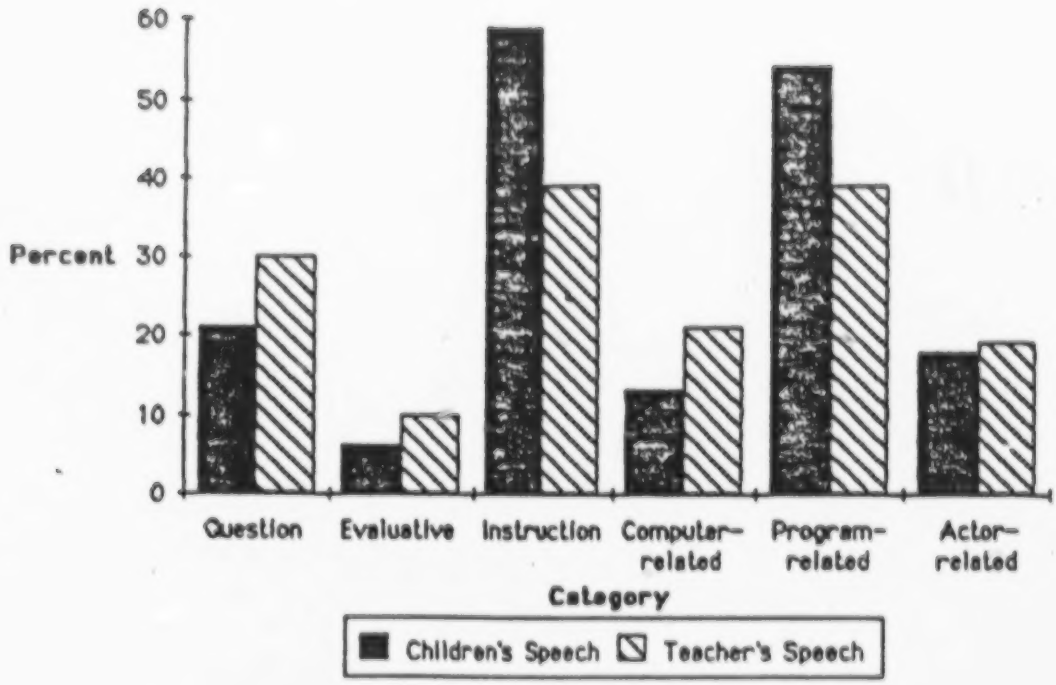
Figure Captions

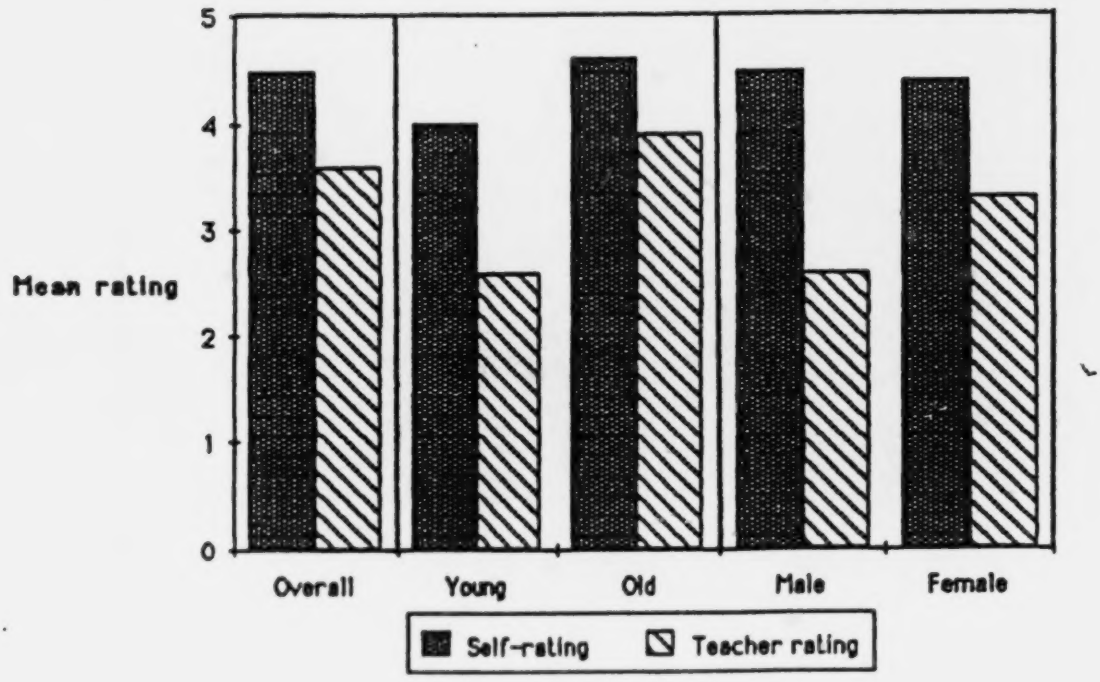
Figure 1. Mean enjoyment rating by the children for computer use in general, with the teacher, with a peer and alone.

Figure 2. Children's and teacher's speech, examined by form and content.

Figure 3. Mean teacher and child ratings of computer ability.


Mean Score
5
4
3
2
1
0
Overall
With the Teacher
With a Peer
Alone


60
50
40
Percent 30
20
10
0
Question
Evaluative
Instruction
Computer-related
Program-related
Actor-related
Category
Children's Speech
Teacher's Speech


Mean rating
5
4
3
2
1
0
Overall
Young
Old
Male
Female
Self-rating
Teacher rating

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